Invention Title: Specialized Mass Additive Garments to Modify the Balances of Athletes

Cross Reference to Related Applications: Patent application number 09/957,809: 'Specialized mass distribution footwear and handwear to modify the internal leverage of athletes'

The methods and articles claimed are independent but more effective when utilized together, modifying both the internal leverage and balances of athletes.

Background of the Invention: Three components of what determines if an athlete can effectively utilize their muscles in performing a sports motion are their 'body balance', their 'hand balance' and their 'foot balance'. The term 'body balance' is used to describe the natural ability of an athlete to keep the necessary posture for performing a particular sport motion while simultaneously being able to effectively utilize their muscle power in performing the motion. The terms 'hand balance' and 'foot balance' are used to describe the natural predisposition of an athlete to apply forces through the hands and feet with a bias toward greater forces being applied through one area of the hands or feet. The term 'components of balance' is used to describe collectively the body balance, hand balance and foot balance.

Summary of the Invention: The invention is a method of differentiating, categorizing, and measuring the body balance, hand balance, and foot balance for a particular athlete and through specialized mass additive garments change these balances to improve athletic performance.

Description of Drawings: Figures 1-4 are referenced in the detailed description of the invention to aid in the understanding of how the components of balance of athletes are differentiated, categorized, and measured as well as how garments are designed or modified for selective mass addition to tune an athlete's balance.

Detailed Description of the Invention:

I. Definition of Body Balance

One component of an athlete's natural ability for a sport is their natural 'body balance'. This 'body balance' is defined as a natural ability, resulting from each athlete's unique body structure, that determines if that athlete can effectively utilize his or her muscle power in performing a sport or sport motion while keeping a posture appropriate to that sport or sport motion. For example, a good sprinter must have the body balance to slightly lean their upper body into the sprint, a required posture, while effectively utilizing their leg muscles to drive them forward. If the sprinter needs to lean too far forward or back to properly utilize their leg muscles their speed would be compromised. Similarly, if the sprinter forced their body into the proper posture, but this caused less effective utilization of their leg muscles, their speed would again be compromised. Thus, the body balance of an athlete is a set of biases, based on their body structure, to be able to perform certain sport motions, combining required posture and muscle utilization, effectively and others less effectively.

II. Definition of Zones of Body Balance

Zones of body balance are a concept, which can be used to analyze the body balance of an athlete by separating the body balance characteristic of the entire body into measurable components based on the body balance in different sections of the body. The body is split into four zones as shown in Figure 1.

The body balance of the athlete in each of these zones is characterized as forward or rearward. This forward or rearward body balance in each zone is an indicator of that body zone's ability to apply inward (forward) force or outward (rearward) force. Specifically, forward balance allows more effective application of the body's muscle power in producing inward, toward the vertical line running through the middle of the front of the body, force and less effective application of muscle power in producing an outward, away from the vertical line running through the middle of the front of the body, force. Rearward balance allows more effective application of the body's muscle power in producing outward, away from the vertical line running through the middle of the front of the body, force and less effective application of inward, toward the vertical line running through the middle of the front of the body, force.

The balance in zone 1 affects the ability of the body to apply forces by pushing or pulling with sections of the body from the head down through the shoulders. The balance in zone 2 affects the ability of the body to apply forces by pushing or pulling with sections of the body from the chest down to above the hips and through any part of the arms or hands. The balance in zone 3 affects the ability of the body to apply forces by pushing or pulling with sections of the body from the hips down to the knees. The balance in zone 4 affects the ability of the body to apply forces by pushing or pulling with sections of the body from under the knees down to the feet. Note that how high or low the body applies a force is not relevant to what zone's balance affects the force application. For example, even if a hand is applying force above a subject's head, it is still affected by the whether the subject's zone 2 balance is forward or rearward as described above.

Thus, an athlete's natural body balance can be categorized as rearward or forward in each of their four zones of body balance.

III. Hand and Foot Balance Definition

The joints and muscles of the hands and feet allow athletes to control the way that forces generated in the body are transferred through the hands and feet. For example, a pitcher throwing a baseball does not simply apply equal forward force to the ball through each of his/her fingers but rather each finger independently applies specific forces in varied directions to achieve a desired effect such as a curved ball flight. The hand balance and foot balance is the characteristic of an athlete, which causes a predisposition to apply forces through the hands and feet with a bias toward greater forces being applied through one area of the hands or feet. This characteristic is a result of the body structure of an athlete rather than a learned skill. For example, when an athlete is performing a 'push up' a downward force is applied through the hands and every athlete will apply much of their force through the heel of their hand. However, if the balance of the athlete's hands were to the forward/outside position, more force would naturally be applied through the outside fingers and less would be applied through the heel of the hand. Similarly with foot balance, when athletes jump some have a bias toward jumping more off their outer toes rather than their inner. While an athlete can control which area of the hands or feet apply the greatest force, effectively overcoming any bias, it can compromise the effectiveness of their muscle utilization. Again looking at the jumping example, those athletes that do not naturally

jump off their inner toes but force themselves to do so may not be able to generate as much overall downward force because they are unbalancing themselves.

These natural biases are categorized as forward, rearward, outside, or inside for hand or foot balances. Forward hand or foot balance refers to a bias to apply more force toward the ends of the fingers and toes respectively, during a force application. Rearward hand or foot balance refers to a bias to apply more force toward the bottom of the palm and back of the heel respectively, during a force application. Outside and inside balance refers to a bias to apply more force with the inside or outside of the hands or feet respectively, during a force application. For example, front/inside hand balance would refer to a bias toward greater force application in a direction toward the index finger. Thus, the hand and foot balances of an athlete are a set of biases toward greater force application in one area of the hand or foot.

IV. Testing and Quantifying the Components of Balance of a Subject

The ability of subjects to utilize their muscles or apply forces affected by the components of balance described in sections II and III can be measured and recorded for the purpose of quantitatively characterizing the components of balance for a subject. For example, with natural body balance, the magnitude of inward versus outward force a subject can generate with the arms and hands extended out 45 degrees forward from the shoulders could be used to characterize how rearward or forward a subject's zone 2 balance is. The same inward versus outward force test could be used for zone 4 balance testing with the foot extended at the same 45-degree angle from the body. Also, this same test could be performed with a subject's chin

and knee for zone 1 and 3 testing. Similarly, a subject's hand and foot balance can be quantified by having the subject perform a force application that would normally be centered in the hand or foot. The subject's forward or rearward bias in their hand or foot balance would be shown by how much off center their particular force application was and in what direction it was off center (rearward/forward, outside/inside). An example of this would be to have the subject stand under a door archway and push straight upward with flat spread hands while having the subject note which area of their hands they are 'pushing through' the most. The same could be done by supporting their body with their hands and pushing down through the feet at the bottom of the archway while noting which area of the feet they are 'pushing through' the most. Each of these tests could also be done with devices to measure the force distributions applied for more accuracy. Note that the characteristics being measured are the 'natural' components of balance for the subject's body and thus muscle contractions that can modify the balances creating 'unnatural' balances must be eliminated. Some examples are as follows. The subject cannot clench their lower back muscles and protrude their butt to pull their zone 2 or 3 body balance rearward. Nor can the forearm muscles be clenched to apply greater force to one area of the hand during testing. Further the shoulder cannot be pushed forward and the upper back contracted to pull the zone 1 balance rearward.

V. Modifying Body Balance through Mass Carrying Garments

The balance in each zone of body balance can be modified through addition of mass to specific areas on the body. Garments would be used as carriers of these masses.

The definition of garments used in this patent is an article, which can be used to attach to the body and support mass at specific locations on the body. This would include pants, elastic bands, armbands, etc. The areas of mass addition to change the forward/rearward bias in each zone of body balance for a subject are as follows and are shown on Figure 2.

The area of mass addition to move the subject's zone 1 balance more rearward is on the front of the leg, halfway between the bottom of the foot and the bottom of the kneecap.

The area of mass addition to move the subject's zone 1 balance more forward is halfway between the bottom of the foot and the bottom of the kneecap on the back of the leg.

The area of mass addition to move the subject's zone 2 balance more rearward is on the front of the leg, between the center of the kneecap and the top of the hip socket, one third of the way up.

The area of mass addition to move the subject's zone 2 balance more forward is on the rear of the leg between the back of the knee and the top of the hip socket, one third of the way up.

The area of mass addition to move the zone 3 balance more forward would be on the upper arm in the line between the inside of the elbow and the middle front of the shoulder, one third of the way up.

The area of mass addition to move the zone 3 balance more rearward would be on the direct opposite side of the arm from the line between the inside of the elbow and the middle front of the shoulder, one third of the way up.

The area of mass addition to move the zone 4 balance more rearward would be on the arm in the line between the base of the thumb and the inside of the elbow; between the joint of the wrist and the back of the elbow, one third of the way up.

The area of mass addition to move the zone 4 balance more forward would be on the direct opposite side of the arm from the line between the base of the thumb and the inside of the elbow; between the joint of the wrist and the back of the elbow, one third of the way up.

The relative magnitude of the forward or rearward balance change would be dependent on the amount of added mass. The listed weighting locations are as precise as possible due to the variance in subject's body structures, height, limb length etc. For each subject, small weighting location changes around the general area listed can be tried to find the exact locations most effective for each individual. (The most effective exact point for each weight addition location described is that which causes the most balance change with the least weight) Note that weighting on the right side of the arm or leg affects the balance on the right side of the body while weighting on the left side of the arm or leg affects the balance on the left side of the body.

The testing and quantifying methods of section IV can be utilized to quantify the forward or rearward changes caused by the mass additions. This is utilized for design of the specialized mass addition garments as described in section VIII.

VI. Modifying Hand and Foot Balance through Mass Addition Garments

A subject's hand balance can be modified by selective perimeter weighting of the area designated in Figure 3 at the front of the hips. Garments would be used as

carriers of these masses. The area of perimeter weighting and the associated change of a subject's hand balance are shown in Table 1.

Table 1: Effect of Weighting on Hand Balance

Area of front hip weighting (along the perimeter of the area shown in Figure 3)	Associated change in hand balance (more bias toward the following direction)
Inside	Inside
Outside	Outside
Lower	Rearward
Upper	Forward

A subject's foot balance can be modified by selective perimeter weighting of the area designated in Figure 3 at the rear of the hips. Garments would be used as carriers of these masses. The area of perimeter weighting and the associated change of the subject's foot balance are shown in Table 2.

Table 2: Effect of Weighting on Foot Balance

Area of rear hip weighting (along the perimeter of area shown in Figure 4)	Associated change in foot balance (more bias toward the following direction)
Inside	Outside
Outside	Inside
Lower	Forward
Upper	Rearward

Note: weighting the corners of the above-defined areas gives a balance effect that is a combination of the defined effects above. Thus, weighting the lower outside corner of the defined rear hip area would move the foot balance toward the inside and forward.

VII. Purposes of Modifying the Body Balances of a Subject

The effect of modifying the components of balance of a subject is to allow different and more effective muscle utilization, which can improve athletic performance. The athletic performance benefits, which can be gained through modifying the components of balance of athletes, are as follows:

1) Sport performance enhancement: The subject is meant to wear the garments while performing the sport in question. The subject's balance is modified to more effectively perform the motions involved in the sport.

2) Athletic training: The subject is meant to wear the garments while training. The subject's balance is modified to allow different muscles or portions of the muscles to be activated easier during exercise. For example, a subject with a very forward zone 1 and 2 body balance can pull the shoulders and arms inward with minimum muscle effort during the arm motions of running. If the subject's zone 1 and 2 body balance is changed to be very rearward the inner stomach muscles will more naturally be contracted during running. This is due to the stomach muscles pulling the shoulder and arms inward to overcome the rearward balance, which favors outward arm motions. Note: this is not utilizing the mass additions as resistance trainers, as demonstrated by the locations and amount of weights. The amount of weight used altering balances in not of the same magnitude as weight resistance, with a common weighting being near 60 grams or 0.13 pounds per location. Further, the locations of the weight are specialized for each person, always in the specific locations shown in Figures 2,3, and 4 for all balance modifications, regardless of the muscle training required. Further the training effects are not caused by a direct force application by the muscles as for example carrying weights during running.

3) Body Shaping

The subject is meant to wear the garments during normal daily activity. The unique body balance of an individual can allow weight to be carried in certain areas of the body with less muscle stress. For example, considering torso weight, a subject with zone 1 and 2 body balance that has neither a significant forward or rearward bias can most naturally pull outward and inward with the shoulders, back and chest in equal amounts to support the weight. In contrast, a subject with very forward zone 1 and 2

body balance bias would have significant muscle stress in attempting to pull back or outward on the shoulders and back if supporting significant frontal torso weight. It is observed that the body will naturally carry weight in those areas that are well supported by the body balance of the subject. Also, an effect of altering a subject's body balance to create a mismatch between body weight location and balance is that the body stresses the mismatched body weight area while attempting to pull it back into a position that is better supported by the subject's unique balance. This stress of the area of significant body weight can promote the break up of this area of body weight if the subject is performing those activities necessary to lower overall body fat content. In other words, if a subject is on a program that is causing them to loose body weight, intentionally changing a subject's balance can help more of that body weight loss to come off certain areas. Thus, intentionally changing a subject's balance to create this stress can in effect help shape the subject's body.

VIII. Method to Design Specialized Mass Addition Garments to Modify Athlete's Components of Balance

To achieve a desired athletic performance improvement the components of balance for an athlete can be tuned per the procedures of section V and section VI. Methods for determining the proper tuning of subjects' components of balance and the design of the associated specialized mass additive garment are as follows:

1) Measure the components of balance of subject A, whom exhibits the desired athletic performance characteristics to quantify each of their components of balance per section IV. (Per section VII, that characteristic could be a certain type of sport

performance, key areas of muscle development, or a certain type of natural body weight distribution.) Design the mass additive garment or garments to modify the components of balance of a second subject to those of the first per the procedures of section V and VI to gain the benefits exhibited by the first subject. Note: certain components of balance may have a greater or lesser effect on the benefits sought and in some cases no effect. For example, hand balance would not significantly effect body shape. Also note, the correlation between which component of balance (body balance, hand balance and foot balance) effect which performance characteristic can be determined by changing only one balance component at a time and observing the effects. However, also note that the effects of modifying balance components are not completely independent. For example, skaters with two different zone 3 and zone 4 balances would also require two different sets of foot balances to properly balance on their skates.

2) For a given subject or group of subjects, define a specific desired change in an athletic performance characteristic. (Per section VII, that characteristic could be a certain type of sport performance, key areas of muscle development, or a certain type of natural body weight distribution.) Quantify and measure the subject's performance in the performance characteristic. Randomly weight the areas defined in section VI and section VII until the performance improvement sought is reached.

After the initial testing is complete, a correlation can then be developed between specific weighting locations and some of the changes in performance characteristics that can be affected by balance.

Appendix 1, 2, and 3 give examples of utilizing the above methods for design of specialized mass addition garments.

Appendix 1: Design of Specialized Mass Addition Garments for a Hockey Player Per Section VIII, Method 1:

Joe is an excellent hockey player with excellent balance for all aspects of the game. John is a recreational hockey player who has significant balance related problems when playing the game. Testing of Joe's components of balance will thus become the predetermined reference that John's components of balance will be tuned to match. John has defined his balance-related problems as

a) An inability to naturally apply horizontal forces to the puck with the blade of his stick flat on the ice, but rather a predisposition to lift the heel of his blade off the ice when applying these forces, disrupting both pushing the puck and shooting the puck.

b) An inability to skate with the proper angle between his skates and the ice. His skate naturally folds to the inside (bottom of the blade to the outside) inhibiting proper mobility.

c) Inefficient skating characterized by a large amount of muscle usage by the back of the legs and very little by the front of the legs.

John and Joe's components of balance are tested and quantified per the methods of section IV. It is found that John's zone 2 body balance is significantly more forward

than Joe's is (John's outward versus inward applied force during testing was 30/70 versus 70/30 for Joe). To correct this 60 grams of mass are added to John's hockey pants at the front of the upper leg location defined in section V. Retesting shows that 60 grams creates too much of a change in John's zone 2 body balance (now 80/20 for John). The weight is replaced with 50 grams and retesting shows that Joe and John's zone 2 body balance is now equal. It is found that John's zone 3 body balance is significantly more forward than Joe's is (John's outward versus inward applied force during testing was 50/50 versus 65/35 for Joe). To correct this, 25 grams of mass are added to John's elbow pads at the upper arm location defined in section V and retesting shows that Joe and John's zone 3 body balance is now equal. Joe's and John's foot balance bias is tested and it is determined that Joe's foot balance is significantly more inward than John's is. 50 grams of weight is added to the outer rear hip area of John's hockey pants per section VI and retesting shows that Joe and John's foot balance is now equal. Joe and John's zone 1 and zone 4 balance is tested and determined to be naturally equal so no weight is added to the lower leg and lower arm areas per section V. Joe and John's hand balance is tested and determined to be naturally equal so no weight is added to the frontal hip area per section VI.

If it was desired to determine which components of balance affects each of Joe's problems, each of the balance corrections could be done singly with performance observations afterwards. It would be observed that zone 2 balance affects the stick angle when pushing the pick to the side for handling or shooting, zone 3 body balance effects the amount of frontal and rear muscle power used in skating and foot balance effects the angle of the skate. This could be recorded for more expedient design of

specialized mass addition garments in the future by knowing exactly the component of balance to tune to a predetermined reference for a particular performance fault.

Appendix 2: Design of Specialized Mass Addition Garments for a Hockey Player Per Section VIII, Method 2:

The characteristics of John's hockey playing is the same as in method I. John's balance is modified with varying weights in one or more of the areas in section V and VI with no reference as to which areas of weighting would effect John's performance nor how much weight would be needed. Eventually through multiple iterations it is determined that 50 grams of weight at the front upper leg location in John's hockey pants defined in section V corrects Joe's stick angle problem. The testing iterations are again performed until the proper 25 grams are added to the elbow pads at the upper arm per section V and 50 grams are added to the outer rear hip area of John's hockey pants per section VI. While the number of test iterations is large for this method and would be even larger if the locations for weighting defined in section VI and VII were unknown, after completion of the tests it can be recorded that lower front leg weighting can effect stick angle during puck handling etc. This relationship could be recorded for more expedient design of specialized mass addition garments in the future by knowing which mass addition areas cause specific changes in athlete's balances to correct dependent performance faults. Appendix 3 deals with a utilization of this shortcut.

Appendix 3: Design of Specialized Mass Addition Garments for a Golfer Per Section VIII, Method 2 (With predetermined references as to which mass addition areas cause specific changes in athlete's balances to correct dependent performance faults.)

Through the methods of section VIII, the relationship between specific sport performance faults and the component of balance adjustments, which will correct them, can be established. For example, two common sets of golf swing faults are hitting with the blade tilted up or down too much through impact and having the hands too forward or rearward at impact. Once the initial testing per Section VIII, Method 1 or 2 is done the following relationships can be discovered:

Zone 1 balance that is too forward causes the blade to tilt down through impact.

Zone 1 balance that is too rearward causes the blade to tilt up through impact.

Zone 2 balance that is too forward causes the hands to be too forward at impact.

Zone 2 balance that is too rearward causes the hands to be too rearward at impact.

Thus mass additive garments can be quickly designed per section V to alleviate these problems when they are observed in an athlete's performance.